Background Terrestrial Radiation Exposure Level Of Cross River University Of Technology (Crutech), Calabar Nigeria

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Abstract— **Background terrestrial radiation survey of Cross River University of Technology (CRUTECH), Calabar was carried out. The study area was divided into twelve (12) locations and investigated. An in situ measurement approach was adopted using a SOEKS ecotester Geiger counter + food nitrate tester. Three (3) reading were taken in each of the location in survey and then an average computed. The outdoor annual exposure dose rate (OAEDR) of each location was also calculated. The measured average background radiation for all the location was (0.07±0.02)μSv/hr while the average OAEDR was found to be (0.13±0.02)mSv/yr. These values fall within the safe radiation limit of 0.13μSv/hr and 1.0 mSv/yr recommended by UNSCEAR (1998). However, results obtained do not indicate any immediate health side effects on the staff and students and the host communities.**

Index Terms— **Ionizing Radiation, Radiation Monitor, Equivalent Dose, Background Radiation, Dose Limit.**

I. INTRODUCTION

Man is by nature of his environment exposed to varying amounts of ambient radiation with or without his consent. The ambient radiation encompasses both the natural and artificial radiation radioactivity in his environment. (Farai and Vincent, 2006). There are many natural sources of radiation which have been present since the formation of earth. This means that our planet is radioactive since time of its formation. This is evident in that a lot of radio-nuclide exist naturally. Apart from those found in nature, human beings also enhanced some artificially. Some prominent examples among the natural type are of primordial radio-nuclides ^{238}U, ^{232}Th, and ^{80}K, in the series of cosmogenic there are ^{14}C, ^{3}H, ^{7}Be, etc. while human induced radio-nuclides are ^{90}S, ^{131}I, ^{137}I, ^{137}Cs etc., which are employed in medical and industrial activities (Jibiri *et al.*, 1990).

Human exposure to ionizing radiation from natural sources is an unending and unpreventable phenomenon on earth. Human exposure to natural radiation exceeds that from all manmade sources (including medical, weapons testing and nuclear technologies) put together. The two main contributors to natural radiation exposure are high speed cosmic ray particles incident in the earth's atmosphere and the primordial radio-nuclides present in the earth's crust which are present everywhere, including the human body (UNSCEAR, 1998).

The fact that radio-nuclides exist everywhere in all components of the environment like air, water, soil, rocks, vegetation, building materials, consumer products, and even in human body makes ionizing radiation produced from it inescapable for living thing. Some exposure to natural radiation sources is modified by human activities and an example is the natural radio-nuclides released into the environment in mineral processing (UNSCEAR, 2000). Jibiri *et al.*, (1993) stated that radio-nuclides are unstable elements and in the process of attaining stability they disintegrate spontaneously and give out dangerous ionizing radiation to the environment. Radio-nuclides and the resulting energetic ionizing radiation produced are not evenly distributed across the globe. However, radiation levels at a particular location relates linearly with the geological formation of such area, (jibiri *et al*., 1993).

Figures from the ICRP report, (1990) imply that radiation dose of about 80% to man comes from natural sources of which radon contributes about 55%. Radon is a decay product of Uranium found nearly in all soils, rocks and minerals and upon inhalation, it penetrates lungs. According to ICRP's report, (1990), the main reason radon initiate damage which often results in cancer of the lungs, when it interacts with cells of the lungs is because it is an alpha-emitter. Ionizing radiation is potentially harmful in that it adversely has health effect ranging from genetic defect to mental retardation in the progeny of expose individuals. Radiation doses that are received at higher level give greater chances of developing cancer by the exposed individual.

Avwiri *et al.*,(2010) stated that the effect of low level radiation dose may not manifest until many years after exposure and there is no level of radiation exposure below which an exposure does not pose a risk to life. External radiation exposure outdoors are from terrestrial radio-nuclides in soil and are so emitted within 15-30cm of the top soil in the earth surface, (Farai and Vincent, 2006).

II. STUDY AREA

Cross River University of Technology with the acronym CRUTECH was established in August 2002 by Cross River State Bill no. 9 which was amended as Bill no. 6 of 2004. The University is the outcome of the merger of three former tertiary institutions; the polytechnic of Calabar, Calabar, the College of Education, Awi, Akamkpa and the Ibrahim Babangida College of Agriculture, Ovonum, Obubra, all owned by the government of Cross River State.

The University took off in October 2002 with five campuses located in Calabar, Akamkpa, Obubra, Ogoja and Okuku dotted over a distance of well over 300 kilometers from one

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end to the other. In September 2008, the University lost the campus at Akamkpa, leaving it with four. It did not, however, lose the programmes run in the campus at Akamkpa as they were transferred to the campus in Calabar. The faculties, Departments and Programmes in the multi-campus University are presently distributed in the various campuses. The University motto is Technology for human advancement. This research work was carried out in the Calabar campus, located in Ekpo Abasi, Calabar South Local Government Area, Calabar.

III. Materials and Method

An Insitu approach of Background Radiation Measurement was adopted using direct dosimetry. A SOEKS ecotester Geiger counter + food Nitrate tester digital alert Background radiation monitor was used. The study area was partitioned into 4 (four) locations. The administrative block comprising of the administrative buildings, the academic block comprising of the Faculty of Science, Engineering, Education blocks respectively, ETF, open field, and PREFAB lecture blocks, and the Hostels. According to Avwiri *et al.*, (2010), the radio geological method of estimating human exposure to sources of terrestrial radiation requires validation by direct dosimetry. For this purpose, a survey of the external gamma radiation levels in these locations was done using this method. A major limitation of this type of survey is that a single measurement represents only one point in an intensity range and may be unreliable as an index of the dose rate integrated over a period of time. But this difficulty was overcome by making repeated measurements to correct for diurnal and seasonal variations. For adequate coverage of the study area, the outdoor radiation levels were taken in 3 (three) points each from the four partitioned locations making it a total of 12 (twelve) points in all.

The SOEKS ecotester Geiger counter + food Nitrate tester was set to Background radioactivity in micro sievert per hour (μSv/hr) and held at a height of 0.1m above sea level. This height of 0.1m was suggested and represented by the international commission on radiological protection (ICRP) (UNSCEAR, 2000), in order to accurately estimate radiation exposure to man. The radiation exposure level was measured and the readings (counts) were obtained. For each point, three counts per hour were recorded and then an average was computed.

The SOEKS ecotester Geiger counter + food Nitrate tester digital alert Background radiation monitor is a health and safety instrument that measures Gamma radiation, beta radiation and X-rays. It has a range of indicated background radiation level from 0.03μSv/hr to 1000μSv/hr, from 3μR/hr to 100,000μR/hr, from 0.3mSv/hr to 100mSv/hr and from 30mR/hr to 10,000mR/hr. The measurement time is up to 20 seconds. The range of the indicated nitrate content, in Mg/Kg is from 20 to 5000. SOEKs ecotester Geiger counter + Nitrate tester has registered gamma radiation energy from 0.1. It has a continuously, numerical and graphical data presentation measurement display and operates in temperature ranging from -20°C to 60°C. The SOEkS ecotester easily gauges radioactivity levels based on ion radiation intensity (gamma radiation and beta particle stream) and X-ray radiation levels. Measurement made with the device display exact background radiation levels in μSv/hr or μR/hr along with a message describing the level of background radiation as thus:

- ❖ Normal background radiation (when bar is green)
- ❖ High background radiation (when bar is yellow)
- ❖ Dangerous background radiation (when bar turns red)

The SOEKs ecotester uses Geiger Muller tube to detect radiation. The Geiger Muller tube generates a pulse of electrical current each time radiation passes through it and causes ionization (Avwiri *et al.*, 2010). Each pulse is electronically detected and registered as a count. Three (3) counts per hour were recorded for each point and then an average taken.

IV. Result and Discussion

UNSCEAR, 1998 recommended indoor and outdoor occupancy factor of 0.8 and 0.2 respectively. This occupancy factor (OF) is the proportion of the time during which an individual is exposed to a radiation field. This work is based on outdoor exposure and outdoor occupancy factor of 0.2 was used to determine the outdoor annual effective dose rate (OAEDR). 8760 hours per year was used to calculate the OAEDR. To convert the average dose rate per hour into an equivalent dose in milli-sievert per year (mSv/yr), the equation below was used:

Outdoor: (x) μSv/hr x 8760hr/yr x 0.2 x 0.001 = OAEDR (mSv/yr) [1]

where x is the average equivalent dose rate in micro sievert per hour (μSv/hr) for each point respectively.

V. Data Presentation and Analysis

The average readings from the 12 locations (points) are presented in table 1 below and the locations from which readings were obtained. The second row in the table consist the locations, the next row features the radiation equivalent dose rate in μSv/hr which further features 3 rows containing 3 sets of readings for each location. The next row is the average in μSv/hr of these 3 sets of readings while the last row features the outdoor annual exposure dose rate (OAEDR) with unit in mSv/yr. The total of the average equivalent dose rate (radiation rate) for all the locations is 0.07μSv/hr and the total OAEDR for all the location is 0.13mSv/yr.

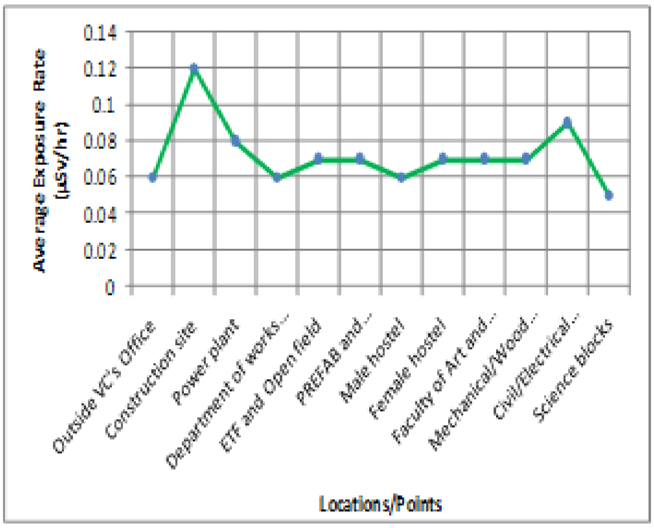

Fig . A Plot Presentation Of Average Equivalent Dose Rate (μSv/hr) and the Respective Locations

Table1. A Tabular Representation of the Data obtained for the twelve locations.

S/N	NAME OF LOCATION (POINTS)	RADIATION RATE IN ±0.02 μSv/hr FOR 3 SETS OF READING			AVERAGE (μSv/hr) ±0.02	OAEDR (mSv/yr)
1	Outside Vc's office	0.05	0.07	0.07	0.06	0.11
2	Construction site	0.15	0.12	0.1	0.12	0.21
3	Power plant	0.07	0.06	0.11	0.08	0.14
4	Department of works main office	0.08	0.05	0.05	0.06	0.11
5	ETF and open field	0.05	0.09	0.07	0.07	0.12
6	PREFAB and surroundings	0.08	0.1	0.04	0.07	0.12
7	Male hostel	0.06	0.05	0.07	0.06	0.11
8	Female hostel	0.08	0.06	0.06	0.07	0.12
9	Faculty of Arts and Education Blocks	0.05	0.07	0.09	0.07	0.12
10	Mechanical/Wood Product Engineeri ng Blocks	0.07	0.05	0.08	0.07	0.12
11	Civil/Electrical Engineering Blocks	0.1	0.09	0.09	0.09	0.16
12	Science Blocks	0.05	0.05	0.06	0.05	0.09

VI. Data Interpretation and Discussion of Results

The average dose obtained from the measurement showed that the background ionising radiation level within the campus is low. The minimum does was registered at the Science Block with an average of (0.05±0.02)μSv/hr while the maximum dose was obtained from the construction site which records an average of (0.12±0.02)μSv/hr. minimum and maximum values obtained clearly indicate that background radiation was not evenly distributed in all points across the campus. The scattered distribution in the plot clearly showed the variation in background radiation across these locations. The analysis of the data pooled together revealed that the average background radiation dose that could be given to an individual within these locations on the campus was (0.07±0.02)μSv/hr, and the average OAEDR for all the locations was (0.13±0.02)mSv/yr. This values fall below the exclusive limit of 0.13μSv/hr and 1.0mSv/yr recommended by the international commission on radiological protection (ICRP) that could pose threat to health as a result of natural background terrestrial radiation.

The construction site which records the highest average background radiation of (0.12±0.02)μSv/hr has an OAEDR of (0.21±0.02)mSv/yr in a single year and will for example in ten years record 1.2mSv and 1.05mSv in five years assuming all radiation sources remain unchanged. That is to say a worker or someone who stays or work in this area on a regular basis within these years must have absorbed these huge doses of radiation and had his protein cells destroyed in the cause of exposure.

VII. Conclusion

Measurement of the natural background radiation exposure levels of Cross River State University of Technology, Calabar was carried out in this work. From the average data obtained, it is evidently clear that the study area falls within a low level background radiation area. As a result, the study area can be pronounced safe in that the average data obtained falls below the international acceptable limit for the public.

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